Cloud variations skew the statistics of near-cloud aerosol properties

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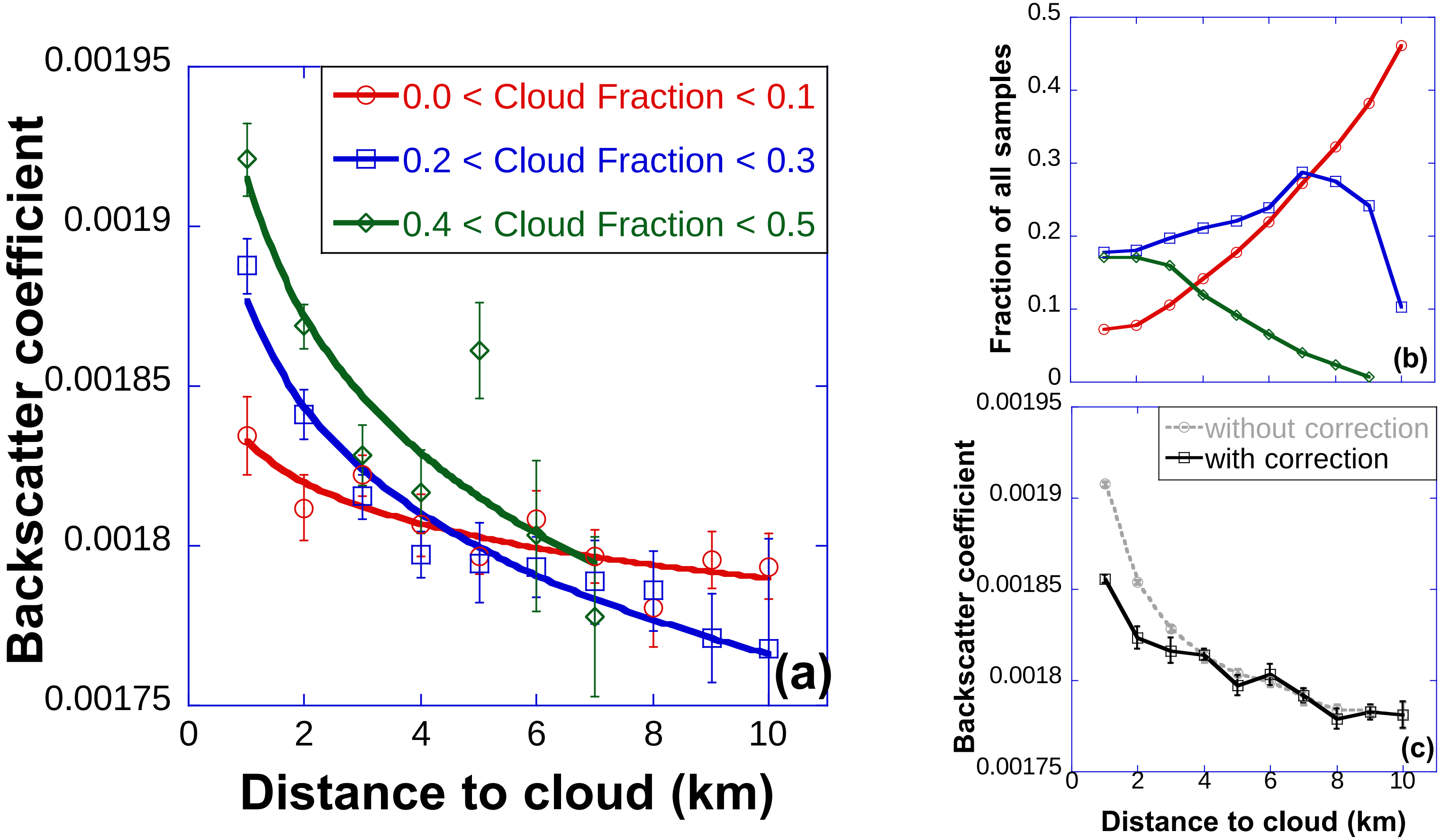

Lidar backscatter from aerosols is known to increase near clouds. The analysis of CALIPSO data indicates that the increase depends on cloud cover, and is strongest when cloud fraction is high (panel a). When composite statistics combine all data from a wide range of cloud fractions, the increase can be distorted. This occurs because near-cloud aerosol backscatter increases with cloud fraction, and areas of high cloud fraction contribute more to composite statistics near clouds than areas far from clouds (panel b). A technique has been developed to avoid overestimating near-cloud aerosol enhancements in overall statistics (panel c).

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References:

Yang, W., A. Marshak, T. Várnaii and R. Wood (2014), CALIPSO observations of near-cloud aerosol properties as a function of cloud fraction., Geophysical Research Lett. (in print).

Data Sources: nighttime dataset of CALIPSO Level1 backscatter measurements, and CALIPSO Level 2 aerosol and cloud products, 2006-06-21 to 2009-06-21 near Azores.

Technical Description of Figures:

Panel a: Medians of backscatter coefficient at 532 nm wavelength from CALIPSO***,*** as a function of distance to cloud for each cloud fraction. It demonstrates that the phenomena of backscatter enhancement near cloud generally exists for all cloud fractions and is more pronounced for larger cloud covers.

Panel b: The aerosol sample fraction as a function to distance to cloud for various ranges of cloud fraction. The plot shows that for low cloud fractions (red curve) sample fractions increase dramatically with distance, while for high cloud fractions (green curve) sample fractions decrease with distance. This variation feature in the sample fraction induces skewed/distorted trend in the composite statistics of aerosol backscatter near cloud.

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Panel c:. The composite statistics of backscatter coefficient with and without the proposed correction. The correction is achieved by resampling the data in such a way that the distribution of cloud fraction is the same for any distances from clouds. In this example, the distribution of cloud fraction was specified by the one observed at the distance of 10 km.

Scientific significance, societal relevance, and relationships to future missions: Understanding the properties of near-cloud aerosol is important for accurate estimation of aerosol radiative forcing. The findings of this research give us new knowledge on how the cloud coverage affects aerosols property near cloud. The effects of cloud coverage have not been considered in earlier studies of near-cloud aerosol properties. These findings will also benefit to the study of near-cloud aerosols using future remote sensing instruments.

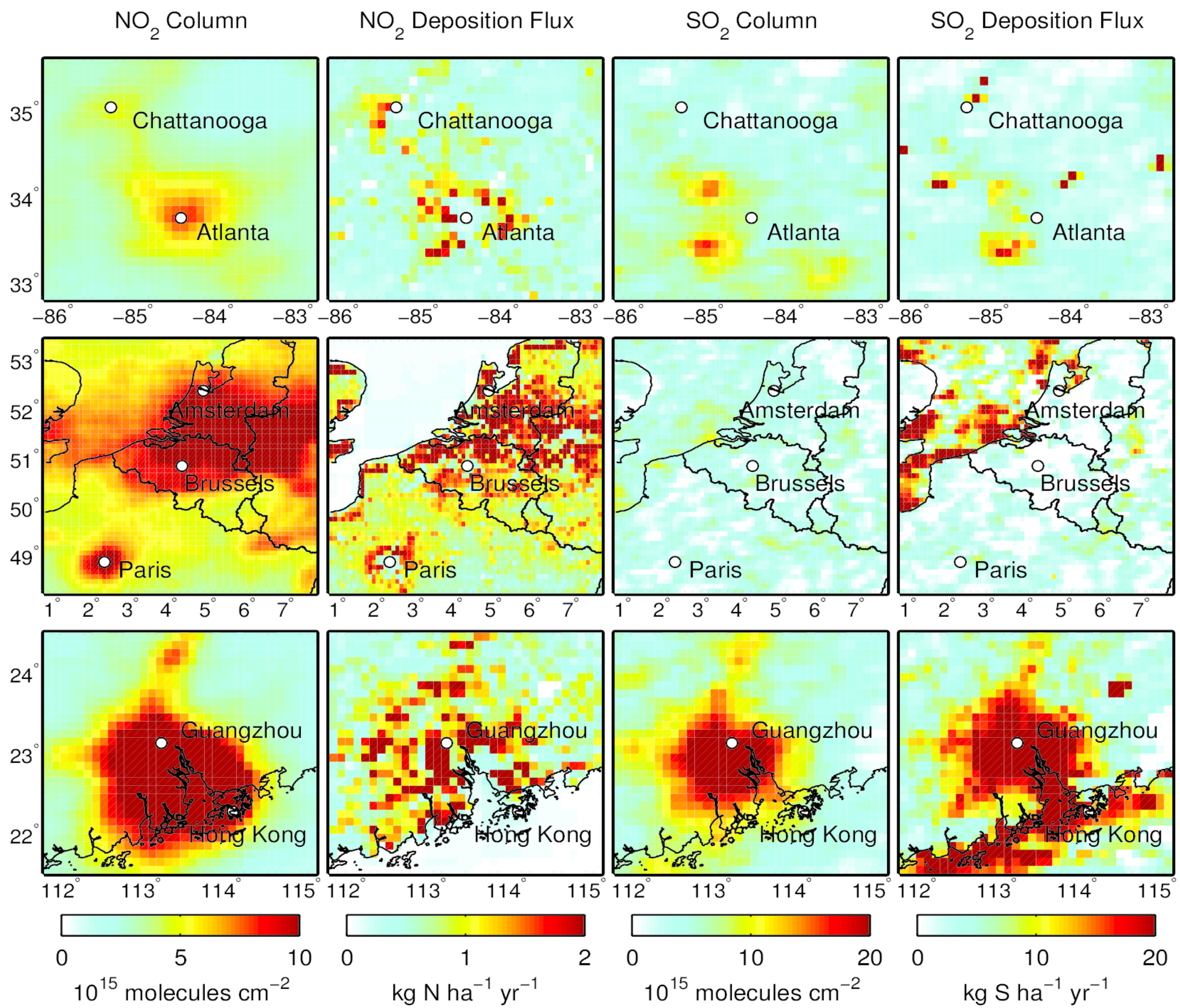
Dry Deposition of NO_2 and SO_2 in Urban Areas Inferred from Aura/OMI

DALHOUSIE UNIVERSITY
Inspiring Minds

Atlanta, GA US

Benelux and North France

Pearl River Delta, China



Annual 2005–2007 mean measurements of NO_2 and SO_2 columns from the Ozone Monitoring Instrument (OMI) in combination with the GEOS-Chem chemical transport model have provided the first global budgets and estimates of spatial patterns of NO_2 and SO_2 dry deposition fluxes.

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References: Nowlan, C. R., R. V. Martin, S. Philip, L. N. Lamsal, N. A. Krotkov, E. A. Marais, S. Wang, and Q. Zhang (2014), Global dry deposition of nitrogen dioxide and sulfur dioxide inferred from space-based measurements, Global Biogeochem. Cycles, 28, 1025–1043, doi:10.1002/2014GB004805.

Data Sources: NASA Aura OMI Level 2 tropospheric NO_2 and SO2 column products.
http://disc.sci.gsfc.nasa.gov/Aura/data-holdings/OMI/omno2_v003.shtml
http://disc.sci.gsfc.nasa.gov/Aura/data-holdings/OMI/omso2_v003.shtml

Technical Description of Figures:

Graphics: The high resolution maps of OMI-derived NO_2 and SO_2 deposition estimates (~10x10 km) offers an unprecedented opportunity to examine the spatial structure of deposition near source regions. In addition, estimates of NO_2 deposition are most valid in high-NO_x source regions, such as urban areas, where NO_2 dry deposition likely dominates atmosphere-biosphere NO_x flux. This figure shows OMI-derived nitrogen and sulfur deposition from NO_2 and SO_2 columns in three areas with significant urban populations and emissions: the city of Atlanta, Georgia in the United States, Benelux (Belgium, the Netherlands, and Luxembourg) and northern France, and the Pearl River Delta in China. The Atlanta and European cases clearly show the pattern of NO_2 deposition in urban regions. NO_2 deposition is largest to vegetated surfaces surrounding high NO_x urban areas, given the low deposition velocities to urban land types. SO_2 deposition is enhanced in regions around Atlanta where there are significant emissions from power plants. High levels of SO_2 deposition that do not correlate with large SO_2 tropospheric columns are over rivers and lakes in the region, reflecting the high solubility of SO_2 (conversely, these appear as low-deposition regions for NO_2, which does not deposit easily to wet surfaces). SO_2 tropospheric columns and dry deposition are typically quite low over northern Europe. SO_2 dry deposition is particularly large in the Pearl River Delta in China.

Scientific significance, societal relevance, and relationships to future missions:

- Dry deposition of atmospheric NO_2 and SO_2 contributes excess nitrogen and sulfur to vegetation, soil, and water.
- Deposited nitrogen can cause eutrophication, leading to a loss of biodiversity.
- Deposited nitrogen and sulfur both have the potential to acidify soil and water, and may influence climate by perturbing the carbon uptake of an ecosystem.

Measurements of NO_2 and SO_2 columns from the Ozone Monitoring Instrument (OMI) in combination with the GEOS-Chem chemical transport model have provided the first global budgets and estimates of spatial patterns of NO_2 and SO_2 dry deposition. These results have potential applications in a range of fields, from atmospheric chemistry to ecology. The upcoming NASA Earth venture mission TEMPO (Tropospheric Emissions: Monitoring of Pollution) will allow dry deposition to be quantified at much higher spatial (few kilometers) and temporal (hourly) resolution.